EEDP-03-7
September 1991

Environmental Effects of Dredging Technical Notes

Long-term Evaluation of Plants and Animals Colonizing Contaminated Estuarine Dredged Material Placed in a Wetland Environment

Purpose

This technical note summarizes data collected between 1983 and 1989 that relate to plant and animal communities colonizing the wetland creation site of the US Army Corps of Engineers/Environmental Protection Agency Field Verification Program (FVP). The management of contaminated dredged material and the mobility of contaminants from the dredged material into plants and animals are also described and related to the evaluation of test results by Lee and others (1991). This site will be evaluated through September 1995 under the Long-Term Effects of Dredging (LEDO) Program.

Background

Long-term evaluation of ecosystems developing on dredged material has been accomplished on some of the marsh creation sites established during the Dredged Material Research Program (DMRP). These sites were not classified as contaminated and their evaluations did not consider contaminant mobility. Contaminated dredged material has been evaluated only on a short-term basis, such as laboratory tests before dredging and disposal operations and during the operational phases of some confined disposal facilities (CDFs). Monitoring is normally conducted during the operational phase of a dredging/disposal project and perhaps during the first year after completion of the dredging/disposal activity. Changes in contaminant mobility may occur over the long-term, but no long-term evaluation data are available to document such changes.

US Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

Additional Information

Contact one the authors, Dr. Charles R. Lee, (601) 634-3585, or Mr. Dennis L. Brandon, (601) 634-2807, or the manager of the Environmental Effects of Dredging Program, Dr. Robert M. Engler, (601) 634-3624.

Introduction

Contaminated sediment was dredged from Black Rock Harbor, Connecticut, in October 1983 and placed in aquatic, upland, and wetland environments as part of the US Army Corps of Engineers/Environmental Protection Agency Field Verification Program (FVP), 1981-1986 (Peddicord 1988). Wetland tests (plant, snail, sandworm, and mussel bioassays) were conducted on the sediment before dredging to evaluate potential contaminant mobility. Laboratory test results were subsequently field verified at the field test site at "Tongue Point," Bridgeport, Connecticut. The results of the wetland creation portions of the FVP and the changes occurring since the completion of the FVP for the wetland creation environment are summarized herein. This technical note emphasizes the contaminant mobility of heavy metals. Contaminant mobility and the progressive development of the wetland ecosystem at this site will be evaluated until September 1995.

Site History

The initial field survey of "Tongue Point" included wetland areas. Plants were collected along several transects. The species collected included *Phragmites australis, Solidago sempervirens* (seaside goldenrod), *Distichlis spicata* (spikegrass, saltgrass), *Juncus gerardii* (blackgrass), *Limonium carolinianum* (sea lavender), *Spartina patens* (saltmeadow grass), and *Spartina alterniflora* (smooth cordgrass). The field survey also listed animals which inhabited the stagnant and intertidal ponds. These included fish, shrimp, sandworms, snails, mussels, clams, and several species of crabs.*

Construction

Before construction, *Spartina alterniflora* was collected from 650 m^2 of the wetland. The construction involved the excavation of material to achieve the desired elevation. The total surface area was approximately 7,060 m^2. A weir was installed and allowed an interchange of tidal flow with tidal pools within the "Tongue Point." At high tide, the water level within the site reaches a depth of approximately 0.3 m (Simmers and others 1989). Simmers and others (1989) provide further discussion of wetland construction.

---

* Lance L. Stewart, Douglas Moffat, Kurt Buchholz, and Michael Coon. 1983. "Field Work Report," unpublished report, Marine Sciences Institute/Sea Grant Advisory program, University of Connecticut, Groton, CT.

Plants

Spartina alterniflora and *Sporobolus virginicus* were used in laboratory and field bioassays. Laboratory tests indicated that the contaminated sediment was not toxic to the saltmarsh plants *Spartina alterniflora* or *Sporobolus virginicus* (drop-seed) when placed in a wetland environment. *Spartina alterniflora* also survived well in the field test. However, *S. virginicus* did not survive in the field (Simmers and others 1989).

One half of the created FVP wetland was planted with *Spartina alterniflora* supplied by Environmental Concern, St. Michaels, Maryland. Initial growth of Environmental Concern's transplants on the FVP field site appeared to be slow up to 1986, but then in 1987, 1988, and 1989, the vegetation on the created wetland gradually expanded until the side planted with Environmental Concern's transplants was covered by a dense stand of *S. alterniflora*. The highest biomass production (798 g/m^2) was observed in 1987. The other half of the wetland was planted with native *S. alterniflora* collected prior to construction of the dredged material created wetland. These transplants were slower to grow in 1986 and 1987, but exceeded Environmental Concern's transplants in 1988 and 1989 (Brandon and others, in preparation).

Contamination of Plants

The 1988 and 1989 plant tissue concentrations are generally no greater than those measured in the naturally occurring *Spartina alterniflora* at "Tongue Point" before wetland creation or those measured in nearby naturally occurring saltmarshes (Table 1). Copper and chromium tissue concentrations are possible exceptions. These metal concentrations tended to be higher than the natural marsh or preconstruction concentrations in 1985, 1986, 1988, and 1989.

Animals

Animal bioassay results from static and tidal simulation tests indicated that tidal simulation procedures are superior to static tests for measuring uptake by organisms in the intertidal wetland habitat (Simmers and others 1989). Comparison of FVP field-collected animal data with laboratory tidal bioassay suggests that tidal simulation bioassay procedures overpredict organic bioaccumulation. No clear pattern between laboratory and field tests emerged for metals (Simmers and others 1989). Native sandworms (*Nereis succinea*) colonized the wetland in 1986. Since 1986, fish, crabs, and snails have been observed in the FVP created wetland. Simmers and others (1989) listed the bird and mammal species observed on this site in August 1984.

Table 1

Tissue Contaminant Contents (μg/g) of *Spartina alterniflora* Grown on Contaminated Estuarine Dredged Material from Black Rock Harbor

Heavy Metal	Natural Marsh*	Field Collected				
		Prior**	1985	1986	1988	1989
	N=20	N=7	N=7	N=7	N=8	N=9
	Concentration, μg/g					
Zn	44.3 (24.8)	22.5 (9.5)	13.5 (5.0)	19.2 (7.1)	21.1 (4.3)	20.3 (8.2)
Cd	0.20 (0.19)	0.17 (0.11)	0.02 (0.05)	<0.003 (0.0)	0.25 (0.05)	0.23 (0.03)
Cu	7.16 (2.16)	3.62 (1.18)	5.65 (1.74)	7.48 (5.55)	16.5 (8.9)	14.0 (13.1)
Ni	2.47 (1.76)	5.64 (2.90)	4.23 (6.13)	0.74 (0.68)	1.1 (0.4)	1.7 (0.9)
Cr	3.41 (1.8)	1.11 (1.70)	10.4 (8.2)	6.17 (5.5)	5.7 (3.4)	6.3 (3.9)
Pb	4.85 (6.5)	2.17 (0.80)	3.45 (4.9)	0.95 (0.9)	3.4 (2.0)	3.8 (3.0)
Hg	0.027 (0.02)	0.003 (0.01)	--	--	0.02 (0.003)	0.02 (0.007)

Notes: N equals the number of samples collected and analyzed. Values given in parentheses are the standard deviations.
* From Simmers and others (1981).
** Samples collected before construction; from Simmers and others (1989).

Contamination of Animals

Snails *Ilyanassa (=Nassarius) obsoleta* were collected in 1988 and 1989 and have been analyzed for contaminant contents (Table 2). The 1988 and 1989 copper, cadmium, and mercury concentrations are less than the respective concentrations of FVP laboratory control snails. It was noted that *I. obsoleta* typically contained elevated levels of copper possibly due to the high copper concentration in the respiratory pigment haemocyanin. Zinc, nickel, chromium and lead concentrations were not measured in the FVP control animals. Organic analyses will be evaluated in a later report.

Table 2

Tissue Contaminant Contents (μg/g) of Snails *Ilyanassa obsoleta* Exposed to Contaminated Estuarine Dredged Material

Parameter	Control Sand*	1988	1989
	N=1**	N=1	N=2
Zn	NS†	878.18	675.2 (31.9)
Cu	2,913	1,335.68	1,881.7 (574)
Cd	8.6	2.9	3.6 (0.5)
Ni	NS	8.79	13.3 (1.6)
Cr	NS	9.02	29.7 (16.0)
Pb	NS	10.21	16.1 (5.3)
Hg	0.26	0.08	0.1 (0.05)

Notes: N equals the number of samples collected and analyzed. Values given in parentheses are the standard deviations.
* From Table 9, Simmers and others 1989.
** One composite sample.
† No sample.

Summary

In the wetland creation field site, there are developing plant and animal communities. The *Spartina* marsh appears to be gradually expanding and it is likely that *Spartina* will eventually cover the entire site. With the establishment of *Spartina*, the mudflat community has been reduced in size and fewer sediment-related species are now present, a trend that is expected to continue as *Spartina* coverage increases. It is also anticipated that through time the animal and plant components of the ecosystem will become more diverse. The extent of the populations and the species compositions of the ecosystems may require management procedures if unanticipated routes of contaminant mobility develop. Continued evaluation will better define the extent and nature of contaminant mobility at the FVP site. This evaluation should include the contaminant mobility of organics into both plants and animals. The development of the wetland ecosystem at this site will be evaluated through September 1995.

References

Brandon, Dennis L., Lee, Charles R., Simmers, John W., Skogerboe, John G., and Wilhelm, Gerould S. "Interim Report: Long-Term Evaluation of Plants and Animals Colonizing Contaminated Estuarine Dredged Material Placed in Both

Upland and Wetland Environments," Miscellaneous Paper in preparation, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Lee, Charles R., Tatem, Henry E., Brandon, Dennis L., Kay, Stratford H., Peddicord, Richard K., Palermo, Michael R., and Francingues, Norman R., Jr. 1991. "General Decisionmaking Framework for Management of Dredged Material, Example Application to Commencement Bay, Washington," Miscellaneous Paper D-91-1, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Peddicord, Richard K. 1988. "Summary of the US Army Corps of Engineers/US Environmental Protection Agency Field Verification Program," Technical Report D-88-6, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Simmers, John W., Folsom, Bobby L., Jr., Lee, Charles R., and Bates, Derrick J. 1981. "Field Survey of Heavy Metal Uptake by Naturally Occurring Saltwater and Freshwater Marsh Plants," Technical Report EL-81-5, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Simmers, John W., Rhett, R. Glenn, Kay, Stratford H., and Folsom, Bobby L., Jr. 1989. "Synthesis of the Results of the Field Verification Program Wetland Disposal Alternative," Technical Report D-89-2, US Army Engineer Waterways Experiment Station, Vicksburg, MS.